Scim: Intelligent Skimming Support for Scientific Papers

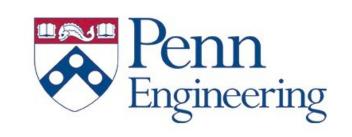
Raymond Fok (presenter), Hita Kambhamettu, Luca Soldaini, Jonathan Bragg, Kyle Lo, Marti A. Hearst, Andrew Head, Daniel S. Weld





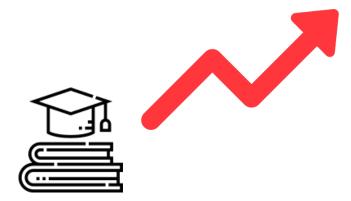
IUI 2023







The Explosion of Scientific Literature



Rate of academic publishing increased ~4% per year, over the past decade.





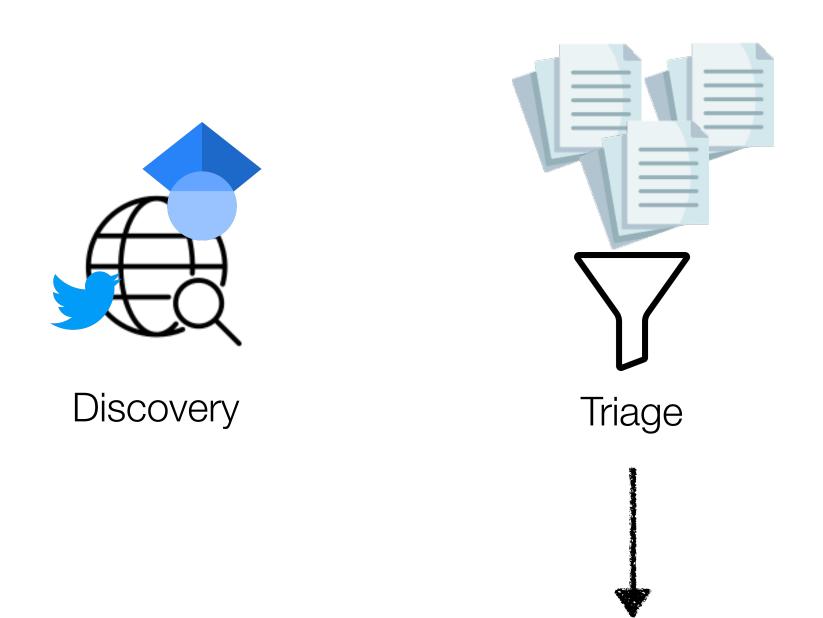


Semantic Scholar

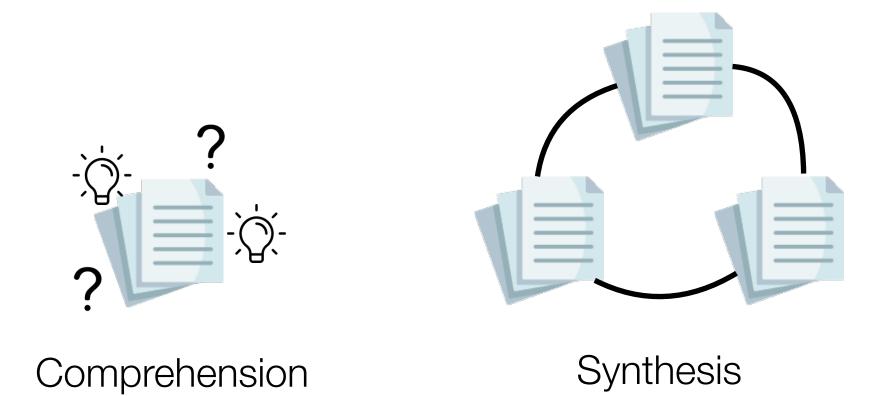
15k+ submissions per month

200M+ papers across all of science

Consuming Scientific Literature



How can we support scholars in triaging the literature more efficiently?





Augmenting Static PDFs

BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding

Jacob Devlin Ming-Wei Chang Kenton Lee Kristina Toutanova Google AI Language

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Abstract

We introduce a new language representation model called BERT, which stands for Bidirectional Encoder Representations from Transformers. Unlike recent language representation models (Peters et al., 2018a; Radford et al., 2018), BERT is designed to pretrain deep bidirectional representations from unlabeled text by jointly conditioning on both left and right context in all layers. As a result, the pre-trained BERT model can be finetuned with just one additional output laver to create state-of-the-art models for a wide range of tasks, such as question answering and language inference, without substantial taskspecific architecture modifications.

BERT is conceptually simple and empirically powerful. It obtains new state-of-the-art results on eleven natural language processing tasks, including pushing the GLUE score to 80.5% (7.7% point absolute improvement), MultiNLI accuracy to 86.7% (4.6% absolute improvement), SQuAD v1.1 question answering Test F1 to 93.2 (1.5 point absolute improvement) and SQuAD v2.0 Test F1 to 83.1 (5.1 point absolute improvement).

1 Introduction

Language model pre-training has been shown to be effective for improving many natural language processing tasks (Dai and Le, 2015; Peters et al., as question answering, where it is crucial to incor-2018a; Radford et al., 2018; Howard and Ruder, porate context from both directions. 2018). These include sentence-level tasks such as natural language inference (Bowman et al., 2015; Williams et al., 2018) and paraphrasing (Dolan and Brockett, 2005), which aim to predict the re-BERT alleviates the previously mentioned unidilationships between sentences by analyzing them rectionality constraint by using a "masked lanholistically, as well as token-level tasks such as guage model" (MLM) pre-training objective, innamed entity recognition and question answering, where models are required to produce fine-grained masked language model randomly masks some of output at the token level (Tjong Kim Sang and the tokens from the input, and the objective is to De Meulder, 2003; Rajpurkar et al., 2016).

There are two existing strategies for applying pre-trained language representations to downstream tasks: feature-based and fine-tuning. The feature-based approach, such as ELMo (Peters et al., 2018a), uses task-specific architectures that include the pre-trained representations as additional features. The fine-tuning approach, such as the Generative Pre-trained Transformer (OpenAI GPT) (Radford et al., 2018), introduces minimal task-specific parameters, and is trained on the downstream tasks by simply fine-tuning all pretrained parameters. The two approaches share the same objective function during pre-training, where they use unidirectional language models to learn general language representations.

We argue that current techniques restrict the power of the pre-trained representations, especially for the fine-tuning approaches. The major limitation is that standard language models are unidirectional, and this limits the choice of architectures that can be used during pre-training. For example, in OpenAI GPT, the authors use a left-toright architecture, where every token can only attend to previous tokens in the self-attention layers of the Transformer (Vaswani et al., 2017). Such restrictions are sub-optimal for sentence-level tasks, and could be very harmful when applying finetuning based approaches to token-level tasks such

In this paper, we improve the fine-tuning based approaches by proposing BERT: Bidirectional Encoder Representations from Transformers. spired by the Cloze task (Taylor, 1953). The predict the original vocabulary id of the masked

Augmentation through automatic highlighting

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1 Introduction

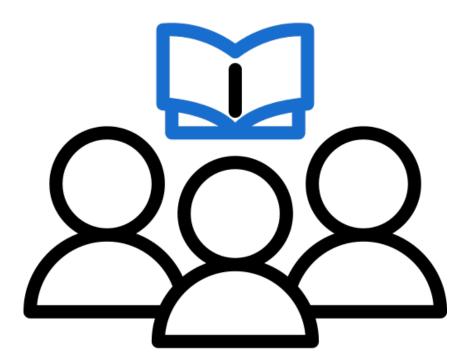
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What do scholars want from a skimming aid?



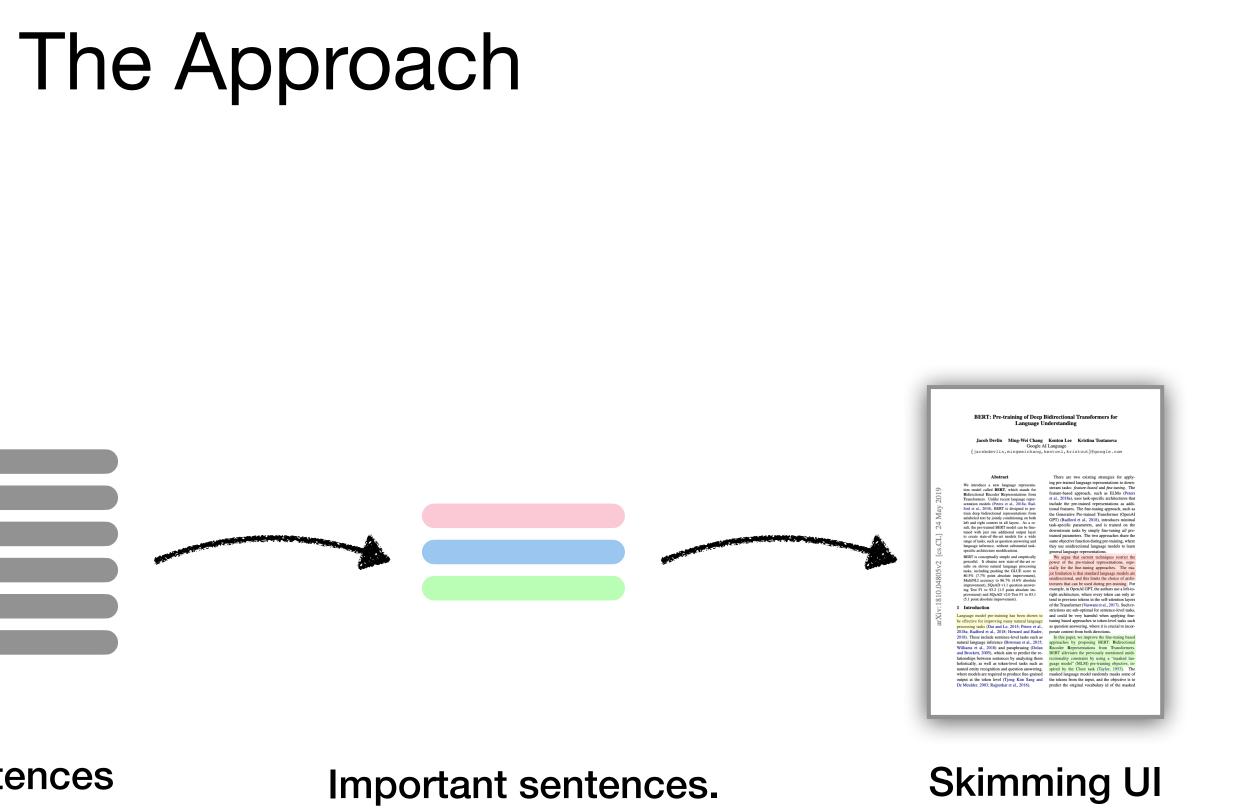
Formative user study with 10 scholars

Design Motivations

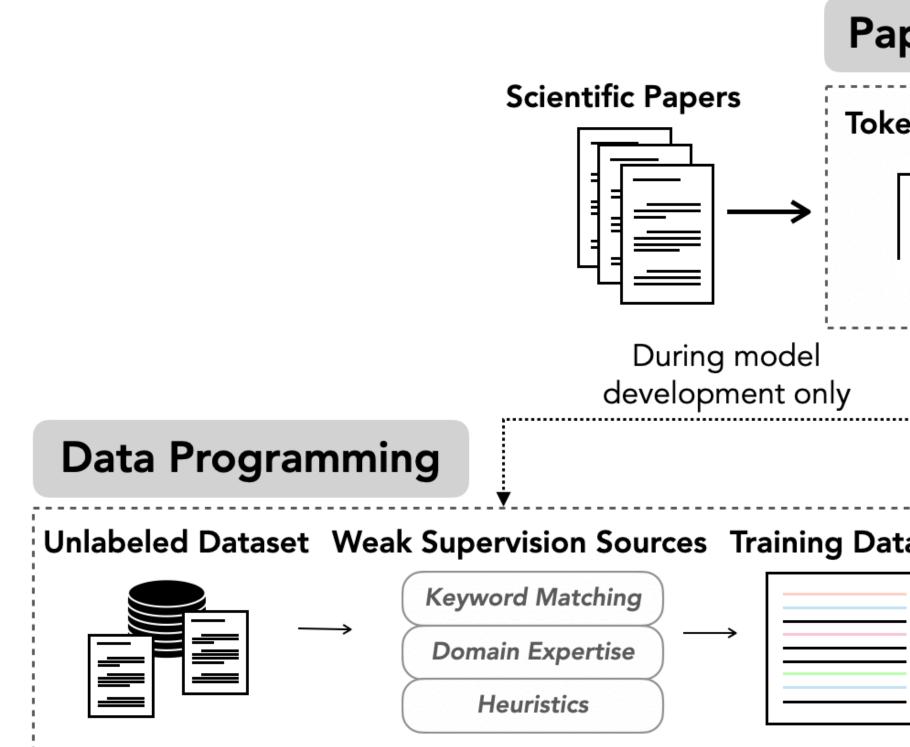
An intelligent highlighting-based skimming aid should...

- Augment readers' skimming practices.
- Highlight diverse kinds of content corresponding to information needs.
- Support skimming through text-dense sections.
- Provide user customization





The Paper Processing Pipeline



per Co	nten	t Extraction		
en Localiz	ation	Sentence Extraction	Metadata Taggin	g
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Aligning Highlights to Information Needs

What are their key results?

OBJECTIVE

Given a cluster of topically related news documents, we aim to detect misinformation at both document level and a more fine-grained event level.

RESULT

Experimental results show that our proposed method significantly outperforms existing methods by up to 7 F1 points on this new task.

Readers often share some common information needs when skimming.

What's new about this work?

Scim identifies **important** sentences, and then labels them with common information facets: Objective, Novelty, Result, and Method.

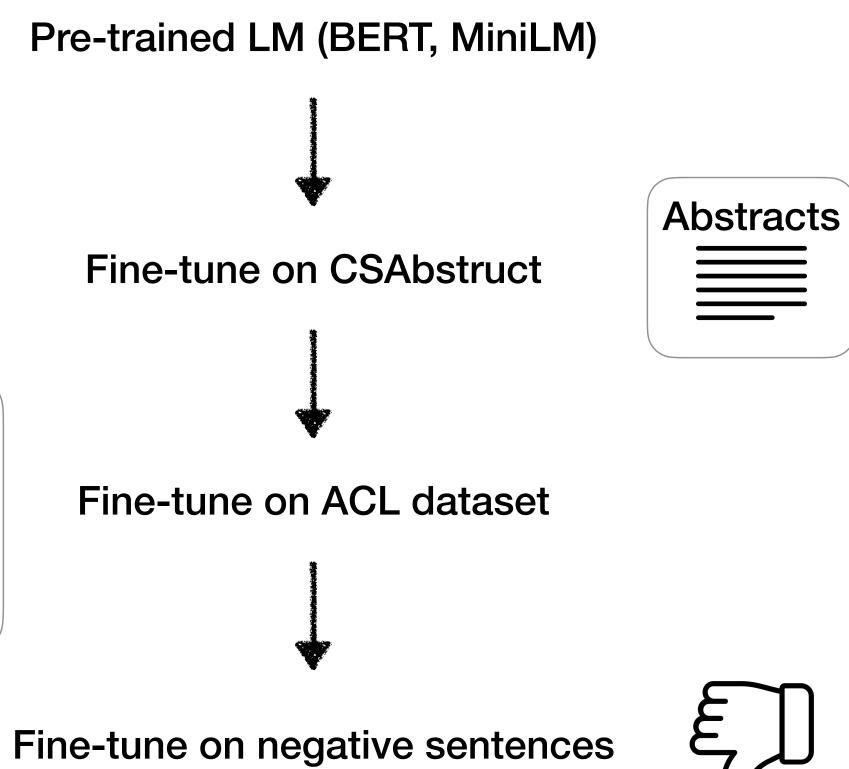
NOVELTY

However, to the best of our knowledge, no published work has considered using cross-document inference for misinformation detection.

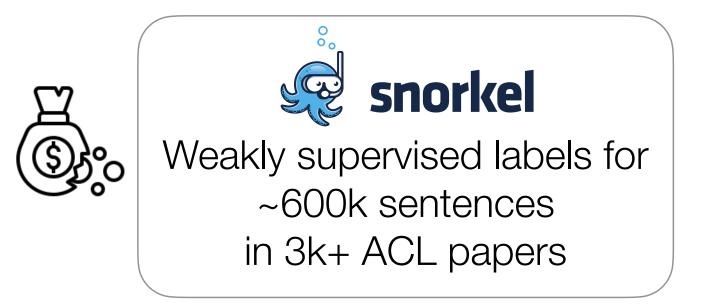
METHOD

We train a generator that generates a document from a knowledge graph (KG), and feed manipulated KGs into the generator to generate fake news documents.

Classifying Faceted Information



Data Programming



107 (1 of 9)	Objective Novelty Method Result	
	tention scores between tokens in self-attention mechanism, are sometimes ineffective as they are learned implicitly without the guidance of explicit semantic knowledge. Thus, we aim to infuse explicit external knowledge into pre- trained language models to further boost their performance. Existing works of knowledge in- fusion largely depend on multi-task learning frameworks, which are inefficient and require large-scale re-training when new knowledge is considered. In this paper, we propose a novel and generic solution, KAM-BERT, which di- rectly incorporates knowledge-generated atten- tion maps into the self-attention mechanism. It requires only a few extra parameters and sup- ports efficient fine-tuning once new knowledge is added. KAM-BERT achieves consistent im- provements on various academic datasets for natural language understanding. It also out- performs other state-of-the-art methods which conduct knowledge infusion into transformer- based architectures. Moreover, we apply our	good chance to scores as well as applications. Recently, there incorporating kri- tectures. ERNIE PLER (Wang et textual corpora an resentation mode work. They need injecting new kn can not benefit points. K-Adapt additional neural of knowledge. It
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tic and semantic information in the self-attention

mechanism. However, the attention maps, which

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portant information

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	Objective (2)	
	Novelty (13)	
	Method (38)	
	Result (19)	
	well as the performance of downstream applications.	
×	In this paper, we propose a novel and generic self-attention mechanism enhanced by explicit knowledge to address problems mentioned above.	
	First, we show a failure case of query-ad matching, which motivates us to inject explicit knowledge into self-attention mechanism.	
	To address the above motivation, we propose a novel architecture, namely KAM- BERT (Knowledge-assisted Attention Maps for BERT).	
	Specifically, we consider three kinds of semantic knowledge to guide the self- attention mechanism, i.e., entity, phrase	

107 ((1 of 9) Objective Novelty Method Result	
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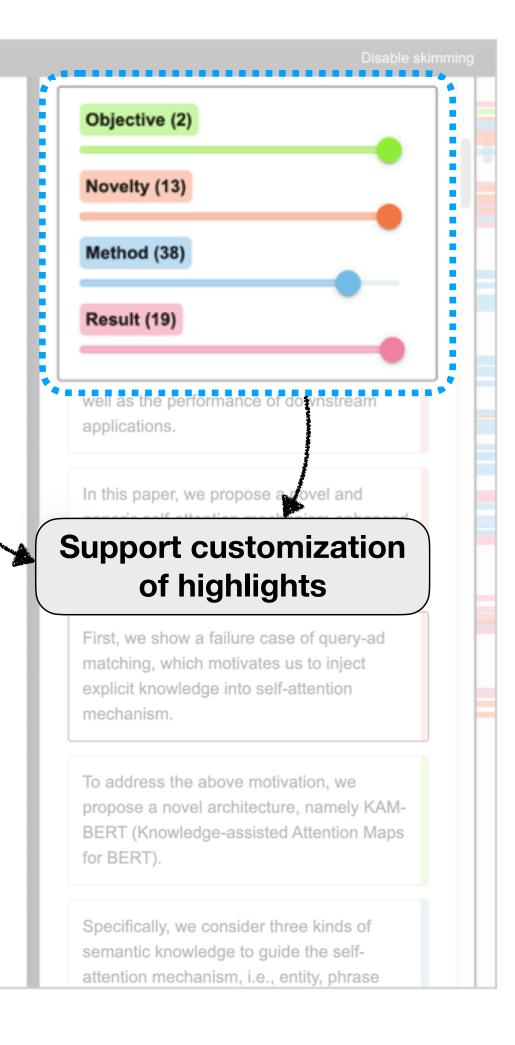
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	Show distribution of highlights at a glance
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107 (1 of 9		Objective				
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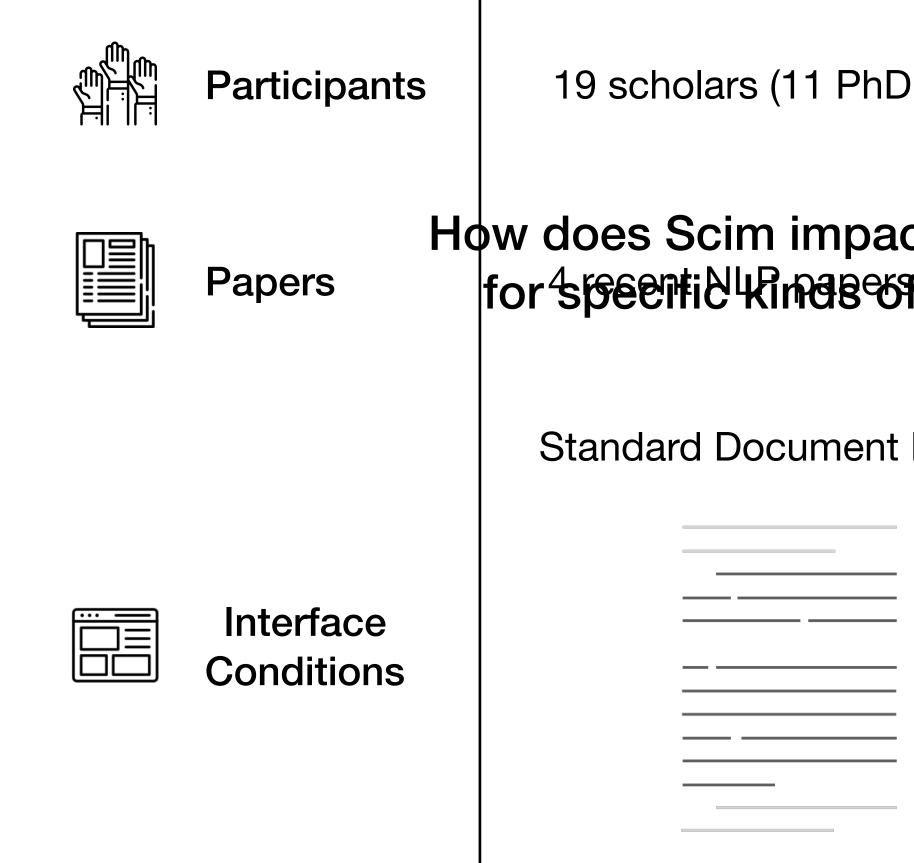
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Study 1: Usability Study



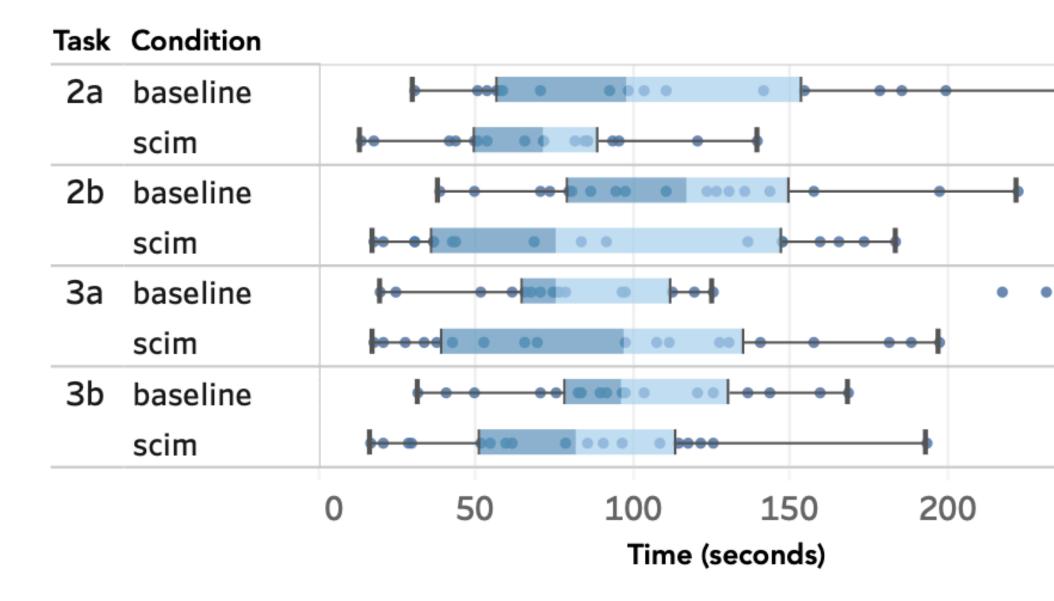
19 scholars (11 PhD, 5 Master's, 2 SWE, 1 industry researcher)

How does Scim impact readers' ability to search for specific Kinese information in a paper?

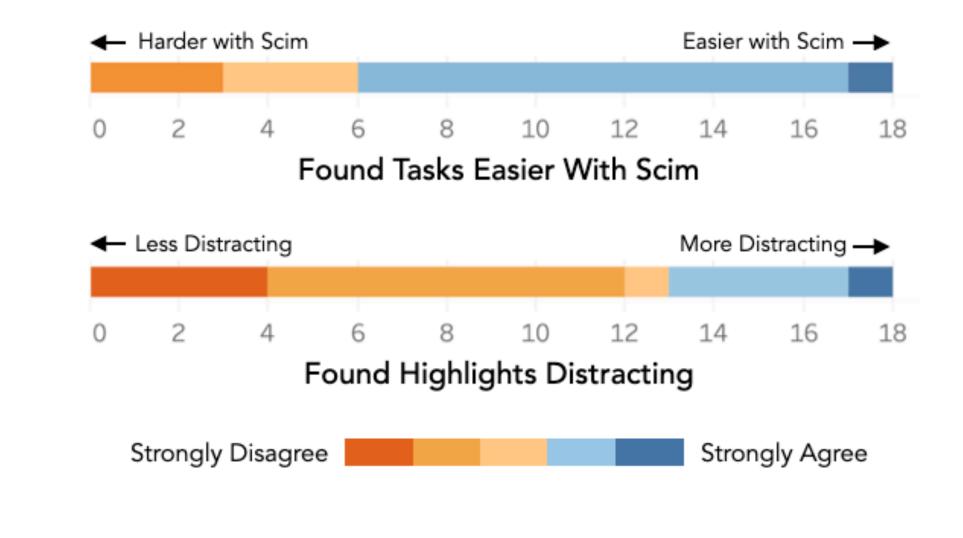
t Reader	Scim			
	(answer in highlights)	(answer not in highlights)		
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Usability Study - Key Findings

Overall, participants completed informationseeking tasks more quickly with Scim than with a standard document reader.

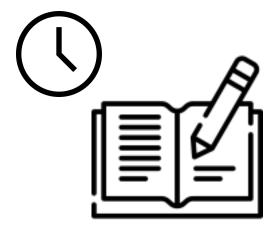


Participants felt information-seeing tasks were easier to complete with Scim, and highlights were not overly distracting.





Study 2: Diary Study



Participants skimmed at least one paper per day, and created a diary entry.

Diary entry prompts:

- - you better skim this paper.

We conducted a **2-week long diary study**

with **12 scholars** (11 PhD, 1 Master's students)

skimming papers of their choice from the proceedings of NAACL '22 How would scholars use Scim for more realistic skimming tasks?

1. Did highlights help you skim this paper? Explain. 2. List one or more ways the system could have helped



Scim's highlights provided an approachable, low-effort summary of high-value information in a paper. Readers could skim only the highlights, yet easily gain more context on-demand.

- Skimming dense texts
- Skimming papers from unfamiliar domains
 - Skimming with low engagement

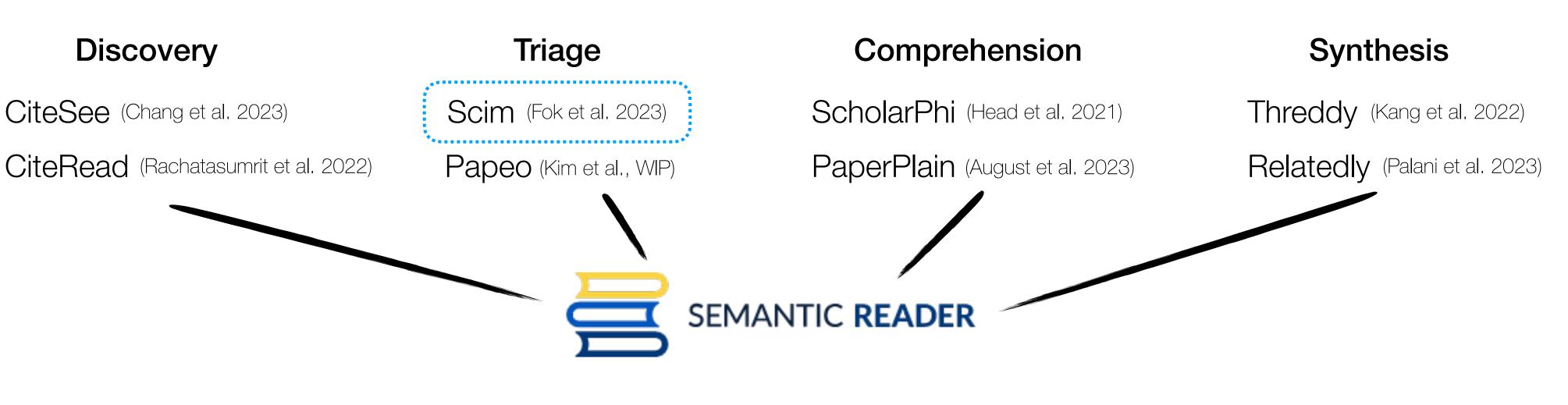


Over the two weeks, participants noted learning how to better skim with an imperfect Al assistant, i.e., with highlights that were potentially inaccurate or irrelevant.

Diary Study - Key Findings

Participants noted Scim was particularly useful for:

Al-Augmented Scientific Reading and Writing



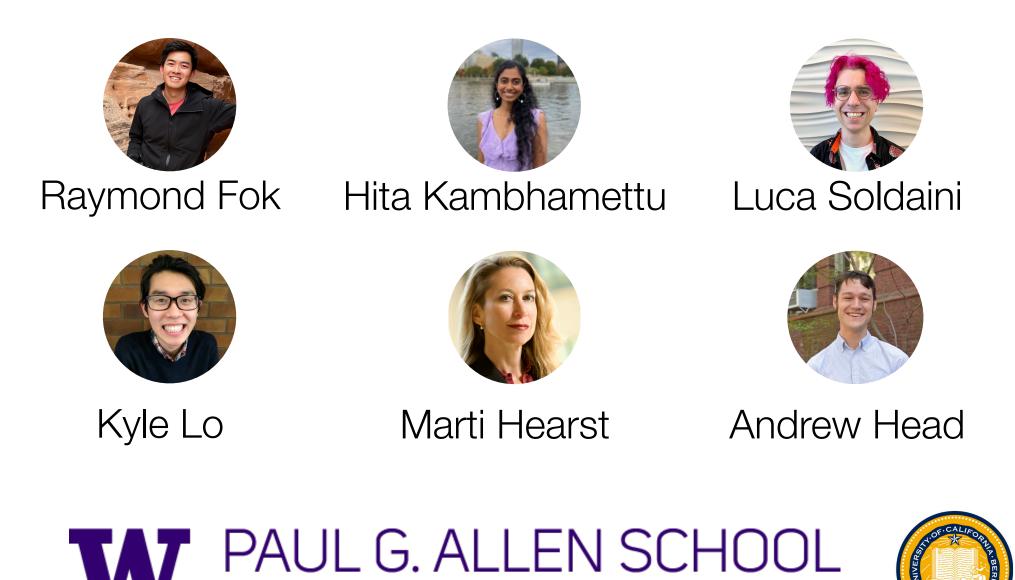
https://www.semanticscholar.org/product/semantic-reader

What's next?

- How should we leverage LLMs (e.g., GPT-4) to support AI-augmented reading?
- How should AI-powered assistants support the creation of academic literature (i.e., writing?)

Scim is an augmented reading interface leveraging intelligent, faceted highlights to support skimming of scientific papers.

Our findings suggest the desire for and promise of AI-powered skimming aids, yet also raise design challenges in augmenting human cognition without introducing undesirable cognitive overload.



OF COMPUTER SCIENCE & ENGINEERING

Summary



Jonathan Bragg



Dan Weld



Paper



Dataset



Code



